OBSERVATIONS OF SAFETY PRACTICES AND CONDITIONS IN JAPANESE COAL MINES

BY RUSSELL G. WARNCKE

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INTRODUCTION

This report is based primarily on a study of safety conditions and practices followed in the coal mines of Japan. Not all of the coal fields in Japan were studied, but typical mines in the largest producing areas and a fair cross section of coal-mine-safety conditions observed during February to April 1948 are described.

Information was obtained through investigations conducted in the mines, discussions with mine-management officials and representatives of labor unions of the various mines visited, and examination of records and statistics from the various offices of the Coal Board of the Ministry of Commerce and Industry and from the Coal Association of Japan. Statistical data covering the same subject, obtained from different sources, varied in many respects and apparently were reported inaccurately, but such discrepancies can be attributed to different methods of reporting and compiling statistics.

SUMMARY AND CONCLUSIONS

It is difficult to correlate the high fatal and nonfatal injury rates that prevail in Japanese coal mines with the conditions observed in the mines. Virtually all mines visited were attempting to prevent accidents and explosions, by apparently following known safety precautions for the prevention thereof. Some commendable safety innovations were observed at several mines; they indicated that mine officials are giving thought and consideration to hazardous conditions that affect their particular mines.

Naturally, the operating officials and management were anxious to impress the writer with their interest in accident prevention and safety. Operating officials were found to be receptive to safety and were interested in formulating definite safety programs. Some mines had well-planned and well-organized safety programs, which, if put into effect, would contribute greatly toward reduction of accidents.

The approach to safety in Japan is quite different from that in the United States, especially the concept of personal responsibility for accidents and the extent to which the individual should be protected against hazards. Management is responsible for providing and maintaining safe working conditions. Collaboration between management and worker, as understood in the United States, does not exist in Japan.

Increase in accidents since the cessation of hostilities is the result of unsettled economic conditions in the coal industry, influx of inexperience workers, and breakdown of discipline among the miners, who have been organized into unions. These unions are greatly influenced by "leftist" tendencies.

It was observed that the Japanese mine worker is fatalistic by nature and has little, if any, noticable safety consciousness. The most urgent major requirements to reduce accidents in the coal mines are to train the worker in accident prevention and instruct him regarding the inherent hazards of his occupation.

Revision of the mining laws would help to reduce accidents if the companies would comply with such laws and provide safer working places and if the workers would cooperate with management and observe and comply with such laws as are enacted for their protection.

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GENERAL GEOLOGY

Although this report deals primarily with safety, it is important to discuss briefly the geological and physical conditions, methods of mining, operation of mines, and production to understand better their effect upon safety in mining. Geologically complex coal measures with much faulted, steeply dipping beds present difficult mining problems. Various methods of extracting and transporting the coal must be employed. These factors have a direct influence upon safety and efficiency in the operations.

The coal mines of Japan are widely scattered over three of the main islands - Kyushu, the southernmost island; Hokkaido, the northern island; and Honshu, the central island. A few mines are on small islands off the west coast of Kyushu. Each island has several widely scattered coal fields, which produce coal of different grades and quality. Roughly, the production of coal can be divided among the islands as follows: 55 to 58 percent from Kyushu and islands off its coast, 27 percent from Hokkaido, and the remainder from Honshu. Although there are many coal fields throughout the islands, only three are large producing areas, namely: Chikuho field, in northern Kyushu; Ishikari field, in Hokkaido; and Joban field, which produces low-grade coal, in northeastern Honshu. Mines in these fields and the Miike field were visited and will be discussed later in detail.

The coals of Japan are Mesozoic and Tertiary in geologic age. The richest and most important coal deposits are Tertiary. Mesozoic coal is found in commercial quantities in only a few areas and is not important. The rank of the coal ranges from lignite to semianthracite; however, most of the coal mined is medium-grade bituminous.

The geological structure of the coal measures in the different fields varies greatly. In many instances this occurs within a short distance in the same field. The coal beds in most fields are much folded and faulted, and overthrust faults are extensive, which causes variation in thickness of the beds by pinching, swelling, or absence of coal. In most of the fields, volcanism produced igneous intrusions of dikes, sills, and plugs, which disturbed the strata in many places and caused coking or alteration of the coal in parts of many mines.

Thickness of the coal measures, number of beds, and quality of coal differ in each field and even within the same field. There are many coal beds in some of the fields, but only a few are worked or are of commercial value. Geological and physical conditions limit the workable beds at each colliery or mine. In general, most coal is produced from mines that work several beds, many of which are separated by only a few feet of rock strata.

The dip of the coal beds varies greatly in the different fields and even within the same fields; however, nearly all the coal is produced from beds that dip 10° to 18°.

The longwall system of mining is used, except in the few mines that employ a room-and-pillar system. The majority of the mines employ an advancing-longwall system in order to avoid extensive development; however, a few mines use the retreating-longwall system.

NUMBER OF MINES AND PRODUCTION

Before the war in 1941, and particularly after the start of hostilities with China in 1937, an intensive effort was made to develop new coal fields, and many new mines were opened. This was apparent from the increase in production to more than 57 million metric tons in 1940; however, since August 1945, production and number of active mines have decreased markedly.

The number of mines as of December 17, 1947 (information furnished by the Coal Association of Japan), is shown in the following table:

TABLE 1. - Number of coal mines in Japan, December 1947

Island	Active mines	Abandoned or idle mines	Total
Hokkaido........................	52	20	72
Eastern Honshu..................	99	58	157
Western Honshu..................	64	50	114
Kyushu..........................	154	24	178
Total........................	369	152	521

These figures reveal that only 70 percent of the mines in Japan were active and producing coal. No reason was given for the large number of idle mines, but apparently many of them were high-cost operations that were opened during the war, and the cost of maintenance was too high to permit operation under prevailing conditions. The scarcity of mine workers and lack of equipment were responsible for the closing of many mines. Although information is not available, it may be assumed that many of the idle or abandoned mines were small properties or mines partly developed.

Table 2 (from the same source as table 1) gives the fields and number of mines in the largest coal fields of Japan, from which 50 to 60 percent of the Japanese coal is mined.

TABLE 2. - Largest coal fields in Japan

Fields	Active mines	Abandoned or idle mines	Total
Chikuho, Kyushu.................	76	7	83
Ishikari, Hokkaido.............	75	16	91
Joban, Honshu...................	35	8	43
Total..........................	186	31	217

The Chikuho and Ishikari fields each produce approximately 25 percent of the total tonnage. The mines in the Joban field produce black lignite and low-grade bituminous coal with low calorific value and high ash content. This coal is important because of the nearness of the mines to the large industrial area and market for coal near Tokyo.

The gradual increase in production from 1932 to 1944, the sudden decrease in production thereafter, and the increase in number of employees are shown in table 3.

TABLE 3. - Coal production, Japan proper, 1932-46

Year	Average number of employees	Production, metric tons	Production per year per employee, tons
1932...............	137,975	28,053,375	203
1933...............	143,602	32,523,746	226
1934...............	168,524	35,924,989	213
1935...............	175,137	37,762,491	216
1936...............	198,346	41,802,711	211
1937...............	222,696	45,257,877	203
1938...............	263,632	48,683,689	185
1939...............	293,019	52,408,541	179
1940...............	335,997	57,318,222	171
1941...............	351,737	55,602,334	158
1942...............	387,757	54,178,544	140
1943...............	409,705	55,538,802	136
1944...............	403,477	49,335,008	122
1945...............	310,716	22,334,538	72
1946...............	341,981	22,523,336	66

Production increased several million tons annually from 1932 to 1940, after which (during the war years) it decreased slightly. A decrease of about 10 percent occurred from 1943 to 1944, which was apparently the result of lack of repair and replacement of equipment, lack of proper development, and shortage of skilled mine workers. The sudden termination of hostilities and the failure of the Japanese economy in 1945 account for the low production in 1945 and 1946.

Increases in employment did not reflect proportionate increases in production from 1935 to 1940. This is shown in the last column of table 3, which gives the production per employee per year. As the number of employees increased, the tonnage per man decreased. After 1940, the rate of production and the total production dropped, except for 1943. The cause of this was not determined, but it is interesting to note that as the production per employee decreased, the percentage of accidents increased, as shown in subsequent tables. This is a good illustration of a drop in operational efficiency and indicates the close relationship that exists between good safety practices, efficiency, and production.

ACCIDENT STATISTICS

Accident records and accident frequency rates are compiled and kept at all mines visited. Some of the companies keep comprehensive, detailed records, consisting of charts or graphs, that give location, cause, type of work, parts of body injured, percentages of injuries, and injury rates for the different causes; however, evidence was lacking to indicate that the information contained in these elaborate charts and records was put to any practical use in planning and directing accident-prevention activities.

Records of accidents are collected by the respective district offices of the Coal Board of the Ministry of Commerce and Industry and by the district offices of the Coal Association of Japan. These data are sent to the central offices in Tokyo, where records are compiled on a national basis.

The frequency of accidents is reported and compiled differently in Japan than in the United States. The Japanese have no uniform or standard method of keeping accident records and calculating rates as is done in the United States. When the various mines were visited, the lack of uniformity in the study and review of accident records was noted. The greatest difference in the method of classifying accidents was found. Some companies record all accidents, even minor ones, regardless of the time lost, whereas others record only those in which three or more days are lost. The terms "total-permanent," "partial-permanent," and "temporary-lost-time" are not used by the Japanese in classifying the severity of injuries. The terms generally used for severity are "serious" (major) injuries, in which 14 or more days are lost from work, and "slight" (minor) injuries, in which 3 to 14 days are lost. Such a classification is general but it is not uniform for different mines and companies.

In Japan, accident-frequency rates are compiled by several methods. The rate of fatalities or injuries for each million tons produced is similar to that in the United States. The Japanese also use the rate per 10,000 tons of coal produced.

Two methods employed by the Japanese in compiling injury rates are (1) fatalities and injuries for each 1,000 employees and (2) the number of fatalities or injuries for each 1,000 man-days. A man-day is equivalent to 8 to 10 man-hours; however, during the war the number of man-hours per day was indefinite.

Frequency rates are not compiled on the basis of man-hours of exposure, as is generally done in the United States. Severity rates, based on the number of days lost in comparison with the total man-hours of exposure, were not given in any of the records examined.

The number of fatalities and injuries and injury-frequency rates from 1932 to 1946 are shown in table 4. It should be noted that one of the rates is based on 1,000 employees.

TABLE 4. - Fatalities and injuries at Japanese coal mines, 1943-46[1/]

Year	Production, metric tons	Number of -		Rate per 1,000 employees		Rate per million metric tons	
		Fatalities	Injuries	Fatalities	Injuries	Fatalities	Injuries
1932..	28,053,375	635	58,562	4.6	424	23	2088
1933..	32,523,746	780	58,178	5.4	405	24	1789
1934..	35,924,989	825	64,474	4.9	393	23	1795
1935..	37,762,491	1,038	62,109	5.9	355	27	1645
1936..	41,802,711	1,051	60,963	5.3	307	25	1458
1937..	45,257,877	884	66,283	4.0	298	20	1465
1938..	48,683,689	1,165	69,178	4.4	262	24	1421
1939..	52,408,541	1,226	78,061	4.2	266	23	1489
1940..	57,318,222	1,354	83,513	4.0	249	24	1457
1941..	55,602,334	1,582	83,739	4.2	238	28	1506
1942..	54,178,544	1,488	84,247	3.8	217	27	1555
1943..	55,538,802	1,670	85,779	4.0	209	30	1544
1944..	49,335,008	1,966	98,738	4.8	245	40	2001
1945..	22,334,538	1,077	49,012	3.5	158	48	2194
1946..	22,523,336	920	61,112	2.7	179	41	2713

1/ Furnished by the Coal Board, Ministry of Commerce and Industry.

The figures in table 4 may be questionable because of the method of collecting and compiling the data, but the table gives an over-all picture of the accident record of the Japanese coal industry for the period during which preparation was being made for war, during the war, and for a few postwar years. The table reveals that fatality and injury rates per million tons fluctuated during 1932-43, but from 1944 to 1946, inclusive, the injury rate increased. The fatality rates for 1944-46 are almost double the prewar figures.

The injury rate on the basis of 1,000 employees may be of interest, but is of little value in analyzing trends of injury rates. This injury rate appears to show an improvement in the injury trend, whereas a closer study of the table will prove this to be a fallacy because production declined. Nevertheless, the table shows that in some years there was an injury for every two to three workers employed.

True comparisons cannot be made between the injury rates of the United States and Japanese mines owing to differences in mining conditions, but it is interesting to note that during the period covered by this table the fatality rate per million tons produced by bituminous-coal mines in the United States decreased from 3.09 in 1932 to 1.50 in 1946, and nonfatality rates decreased from 152.3 in 1932 to 82.7 in 1946. Thus it would appear that the fatality rate in Japan for 1946 was 27 times greater than in the United States and the nonfatal rate was 33 times greater. Fatality rates in European coal mines compare closely with those in the United States, and the above comparison was used to show how Japanese rates greatly exceed those of the United States and Europe.

The excessively high fatality and injury rates in Japanese coal mines are emphasized in the following table:

TABLE 5. - Number of metric tons per fatality and injury in Japanese coal mines

Year	Tons produced per fatality	Tons produced per injury
1932...........	44,200	480
1935...........	36,400	610
1940...........	42,300	690
1941...........	35,100	660
1942...........	36,400	640
1943...........	33,300	650
1944...........	25,100	500
1945...........	20,700	460
1946...........	24,500	370

This table implies that numerous hazards are present, safeguards are absent, or safety consciousness is lacking in most Japanese mine workers - probably a combination of all three factors. The tonnage produced for each fatal or nonfatal injury is very low. The tonnage per fatality decreased rapidly during the war, from 1940 to 1945. Similar decreases, although not in the same ratio, were noted for injury rates.

If the bituminous-coal industry of the United States had injury rates similar to those in table 5, approximately 22 thousand fatalities and over 1 million injuries would have occurred in 1946. Between 500 and 600 thousand tons of coal are mined in America for each fatality, and many mines produce more than a million tons annually without a fatality. In 1947 the bituminous-coal mines in Pennsylvania established an outstanding record by producing more than 1 million tons for each fatality.

Tables 6 and 7 show the number of fatalities and nonfatalities, respectively, by principal causes, from 1938-1946. Fatalities and nonfatalities caused by falls, transportation, and miscellaneous underground causes, and surface accidents increased each succeeding year until 1944. After 1944, there has been a marked decrease in the number of accidents; in 1945 there were approximately one-half as many as in 1944. Although the number greatly decreased, it does not necessarily follow that the trend of accident rates is down. Whereas the number of accidents decreased, the frequency of accidents showed a marked increase. The number of employees decreased about 25 percent during 1945, following the cessation of hostilities. Many mines were closed because workers left them, and production decreased from 49 to 22 million tons.

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TABLE 6. - Fatalities by principal causes, 1938-46

Year	Underground					Surface	Total
	Falls	Haulage	Explosions	Inrush of water	Miscellaneous		
1938....	481	188	276	23	129	68	1,165
1939....	520	237	242	15	137	75	1,226
1940....	682	278	130	40	170	57	1,357
1941....	789	267	265	34	152	75	1,582
1942....	777	271	127	0	221	92	1,488
1943....	809	339	259	0	197	66	1,670
1944....	950	372	267	0	274	103	1,966
1945....	517	136	97	2	254	71	1,077
1946....	419	90	40	3	265	103	920

TABLE 7. - Nonfatalities by principal causes, 1938-46

Year	Underground					Surface	Total
	Falls	Haulage	Explosions	Inrush of water	Miscellaneous		
1938...	26,316	11,249	95	12	23,879	7,627	69,178
1939...	29,824	12,899	251	14	26,894	8,176	78,058
1940...	32,578	11,936	96	3	28,699	8,770	82,082
1941...	32,631	13,884	185	28	28,366	8,671	83,765
1942...	32,845	14,429	128	0	27,525	9,320	84,247
1943...	33,683	14,923	133	0	26,093	10,947	85,779
1944...	38,459	17,406	282	0	30,106	12,475	98,728
1945...	18,235	3,740	82	8	19,212	7,737	49,014
1946...	21,164	2,283	121	16	28,049	9,479	61,112

Whereas the number of accidents decreased, the frequency of accidents showed a marked increase. The number of employees decreased about 25 percent during 1945, following the cessation of hostilities. Many mines were closed because workers left them, and production decreased from 49 to 22 million tons.

The cause of most accidents in Japanese mines, as in all coal-producing countries, is from falls of roof and face. Approximately 50 percent of all injuries result from this cause.

Haulage is the second principal cause of injuries; 17 to 20 percent of all fatalities and 15 to 17 percent of the nonfatal injuries result from this cause.

Explosions of gas and coal dust cause a large number of fatalities in Japanese coal mines. During the period 1938-46 a total of 339 explosions occurred - an average of about 38 a year - causing 1,703 fatalities and 1,373 nonfatalities, an average of 5 fatalities for each explosion. The number of explosions was considerably less in 1946 - 15 with 40 fatalities.

Some of the greatest disasters in the history of coal mining have occurred in mines under Japanese management. The explosion in Honkeiko colliery, Manchuria, on April 26, 1942, caused 1,527 fatalities and 268 injuries. An explosion at Fushun collieries, Tashan, Manchuria, in June 1917, took 917 lives. Although these explosions did not occur in Japan proper, nevertheless the mines were managed and operated by Japanese. Another explosion at the Hogyo colliery, Kyushu, in 1914 caused the death of 667 workers.

Many of the explosions probably could have been averted and many lives saved if ventilation at the working faces had been better and by the judicious use of rock dust.

Miscellaneous accidents consist of injuries caused by explosives, machinery, electricity, and other causes, all of which account for 10 to 12 percent of all fatalities and about one-third of all nonfatal injuries.

COAL-MINE INSPECTION AND SAFETY EXPERIMENTAL STATIONS

The inspection of coal mines in Japan is under the jurisdiction of the district offices or bureaus of the Coal Board, an agency within the Ministry of Commerce and Industry. The inspection service and administration of safety laws is a branch of the Production Division of the Coal Board. The central office is in Tokyo, and district Coal-Board offices are situated near the centers of the large coal fields in the islands. Each district office has several branch offices. Inspectors and part-time inspectors are assigned to the various district and branch offices and inspect or visit the mines in the respective jurisdictions.

The following report of the Ministry of Commerce and Industry gives the names of the district offices and number of inspectors as of March 31, 1948:

Name of office	Number of inspectors		Total
	Full time	Part time	
Coal Board, Tokyo	7	0	7
Fukuoka (Kyushu) Coal Bureau	48	22	70
Sapporo (Hokkaido) Coal Bureau	18	11	29
Taira (Honshu) Coal Bureau	8	5	13
Ube (Honshu) Coal Bureau	10	8	18
Total	91	46	137

A part-time inspector, in addition to devoting part time to mine inspections, performs other work in the Coal Bureau. Each of the above-named offices, except Tokyo, has several branch offices situated at or near large coal-mining centers.

A study of reports prepared by the district offices showed that gassy mines are inspected more frequently than nongassy mines. Discussions with officials and mine workers at the mines visited disclosed that government inspectors had inspected their mines within the past year. The thoroughness of these inspections could not be ascertained, because no reports of safety inspections were available for examination. The district reports that were examined indicated that thorough and concise records are kept on ventilating equipment, other mining equipment, air readings, quantity of methane produced at each mine, and injuries. The effectiveness of the present inspection of mines could not be determined; however, it was ascertained that before the war the inspection of mines was more thorough, and more emphasis was placed on safety. Moreover, during the war, safety was given little if any consideration, as all efforts were devoted to increasing production. The great increase in accident rates during the postwar period was evidence that production was stressed at the expense of safety in the mines.

Coal-mine safety laws were changed and rewritten in 1929. In 1940, a well-written ordinance for Class A (gassy) mines was enacted. This ordinance required the use of approved (permissible) electrical equipment and explosives, rock dusting, closed lights, and many other provisions; however, from the numerous explosions that occurred subsequent to the adoption of the ordinance, it appears that its provisions were not strictly enforced. The war occurred shortly after the ordinance was enacted, and because of the difficulty of procuring parts for replacement and maintenance of mining equipment, which had no priority, it may have been difficult or impossible to enforce the provisions of the ordinance.

At the present time a new coal-mine safety law or code is being promulgated, which will give powers of enforcement to the agency administering the law. It also is proposed to establish a separate safety-and-inspection division, which will be on the same level as other divisions and not a subordinate part of a larger division, as in the present organization. The adoption of a new safety law and the estaablishment of an agency with enforcement powers and duties relating solely to mine inspections and mine safety undoubtedly will assist in reducing the high accident-frequency rates in Japanese coal mines.

The Coal Board, which is responsible for coal-mine safety and inspection, maintains two safety-experimental stations, both known as the "Research Institute for Prevention of Coal-Mine Explosions." One is at Sapporo for the mines of Hokkaido, and the other is at Nogata in northern Kyushu for the mines in Kyushu. Both of these stations are a part of the inspection service and cooperate closely with it.

The Nogata station was established in 1915 as a flame-safety-lamp station attached to the Fukuoka Mine-Inspection Department. Later this station took over the facilities of the Chikuho Coal-Mine Association and was equipped with a testing gallery. In 1936 the institute began to study and test electrical equipment and instruments for mine use. In 1938, it was fully established as a coal-mine-explosion-prevention-research institute.

The activities of the institute are chiefly concerned with the prevention of explosions of gas or coal dust in coal mines. Coal-mine explosives, electrical equipment, and instruments that are likely to ignite gas or coal dust are examined and tested for official approval for use in the mines. The institute is equipped with a testing gallery (similar to the Bureau of Mines testing gallery at Bruceton, Pa.), ballistic pendulum, impact machine, and laboratory for the testing of explosives. Electrical equipment is tested in steel cabinets of different sizes, but the testing is limited to small-size equipment, because the largest cabinet is 8 by 4 by 4 feet. Flame safety lamps are tested in a lamp-testing gallery similar in size and construction to the one at the Bureau of Mines Central Experiment Station, Pittsburgh, Pa.

In addition to tests on explosives and electrical equipment, tests are made on all methane detectors and anemometers before they are approved for underground use, and or semiannual or annual tests are made on all detectors in service. Anemometers are sent to the institute for checking and calibration.

Research and tests are conducted on the explosibility of coal dusts from all Japanese coal beds and on the utilization of rock dust to prevent the propagation of dust explosions.

The institute at Sapporo, Hokkaido, was established in 1938 for the purpose of conducting research on the prevention of coal-mine explosions; however, the buildings were not completed nor the equipment installed until late in 1939, so it was not until 1940 that work was started. Activities and research are similar to that performed at the Nogata Institute. The work and research conducted at both institutes have been of great value to safety in Japanese coal mines, and they should exert a greater influence in the future.

Information pertaining to safety in mines should be more widely disseminated than at present. Reports on investigations and research are published as technical papers and read before technical societies or associations; however, more would be gained if the results of research in safety were published in the form of circulars for distribution to all those interested in mining, particularly the mine worker.

MINE RESCUE

Training and instruction of miners in the use of self-contained breathing apparatus are sponsored and conducted by district coal associations or by groups of coal operators. The frequency of gas and coal-dust explosions in Japanese mines undoubtedly has had a beneficial influence on both the efficient maintenance of rescue stations and the training of miners in the use of rescue apparatus. Rescue stations are maintained at all large mines that were visited. These are equipped with self-contained oxygen breathing apparatus and accessories, and rescue crews are well-trained. Equipment from neighboring mines is available for use at mines lacking mine rescue facilities.

The equipment examined was in good condition, well-maintained, and always available for use. The equipment was stored in separate buildings or in a section of a large building, and one or more persons were responsible for its maintenance. Each mine has trained men (the number depending on the size of the mine) who are organized into teams of relief squads, which are available in the event of disaster. These men are regular members of mine-rescue crews and receive small monthly payments in addition to their regular wages. Training periods, at least four times a year, are required of each, for which additional compensation is paid.

In Hokkaido, the training of workers was under the direction of the Hokkaido Coal Mine Rescue Association. The director of this association has assistants who conduct training at the mines belonging to the association. All the large mines in the Hokkaido coal fields have a large number of men trained for rescue and recovery work. One mine visited has 76 trained men and 63 sets of apparatus; another has 93 trained men and 25 sets of apparatus.

A large mining company in the Iskikari coal field has opened a small mine that is used exclusively for training purposes. The mine for training is opened in a hillside by two parallel entries driven level for a short distance, then dip 20° for a short distance, and finally become level again. Crosscuts are driven between the entries, and short rooms and levels are driven off the entries. A furnace was built alongside one entrance for filling the mine with smoke while men were in training. The mine was designed to simulate conditions that follow explosions. Obstacles such as rock falls, low passageways, and other obstructions are provided. Men are trained to erect doors, hang brattice, build stoppings, and do other necessary recovery work.

Men who complete the initial training course (which requires 5 days) are given certificates; however, to be members of rescue crews and receive extra compensation, additional training is required at least every 3 months. As of December 31, 1948, 1,123 men have been trained in rescue work, and 386 sets of apparatus are available at member mines, according to a report of the Hokkaido Coal-Mine Rescue Association.

At Nogata, on Kyushu, the Japan Coal Association maintains a well-equipped mine-rescue station for training, instruction, and research in mine rescue work. The station is staffed with seven employees and has complete facilities for repairing equipment and training men. It is also equipped with a large, nonflammable training gallery, about 75 meters long, built in the form of a single entry with several turns. Side galleries are connected to the main one to similate rooms or cross entries. Several heaters are installed in the gallery to raise the temperature to reproduce conditions that may be found at mine fires or after explosions. A furnace is used to fill the gallery with smoke during training periods.

Certificates are issued to those who successfully complete the mine rescue course, and additional training is required every 3 months for members of the mine rescue crews.

The association reports that up to March 1948, 3,455 men had been trained; 1,399 trained men were available on Kyushu, and 455 sets of apparatus were available at the member mines.

The rescue apparatus used is of Japanese manufacture and is patterened after the German Draeger, but is modified in design and construction. Masks or half masks are used instead of a mouthpiece, nose clip, and goggles such as are used with most apparatus manufactured in the United States. Only a few gas masks similar to our universal-type gas masks were found at any of the stations.

Two models of mine rescue equipment are used; the more recent model is an improvement over the older model. The later model differs in the operation of the bypass valve. The bypass valve is a push-button-type valve placed at the bottom center of the apparatus near the reducing valve. The valve is operated by a slight pressure or a push of the button, and the oxygen bypasses the reducing valve from the high-pressure line to the intake breathing bag. This is reported to be a much simpler operation and is considered safer than controlling the bypass oxygen with a wheel valve placed on the valve stem of the oxygen bottle.

FIRST AID

It is said that first-aid meets were held by Japanese mining companies before the war and that some first aid was taught the miners; however, little evidence of first-aid training or first-aid equipment was observed in many of the mines visited. Several companies had men (mostly staff members) who administered first aid and had first-aid equipment underground. The members of the rescue or relief squads were taught first aid and supposedly rendered it to those injured underground. Generally, first-aid training on the scale practiced in the United States is unknown in Japan, which probably accounts for the lack of safety-mindedness of Japanese workers.

SAFETY ORGANIZATIONS

It would be difficult to evaluate the Japanese safety organizations as they seemed to exist at the mines visited. At each mine there was a general director or supervisor of safety for the entire operation. Someone also was responsible for safety in each pit, surface operation, or department. Some companies had a director who devoted full time to safety, whereas in others a plant manager, chief engineer, or director usually was in charge of safety and had staff members responsible for safety in their respective departments.

Nearly every mine had a large, well-planned safety organization. Unfortunately, these appeared to be organizations on paper work only, as inspections of the mines revealed little evidence that the work of the safety organization was effective. The safety department at some of these operations had several hundred employees who supposedly were responsible for some phase of safety in or around the mines. Few of these numerous employees, such as fire bosses, safety-lamp attendants, all workers known as guards, and many production employees devoted full time to safety work; they shared the responsibility with supervisors who, in turn, were accountable for their departments or sections. The personnel of the safety organizations did not seem to have a real understanding of safety nor the ability to apply safety measures.

Safety committees have been organized at many mines within the past year and are composed of members selected from the staff and from the mine workers' union. The duties and functions of these committees are not the same at all the mines. Generally, their duties are to inspect mines, report hazards, recommend the correction of existing hazards, investigate and discuss accidents, and assist the safety department. At some mines the committees have been an asset and have helped to reduce accidents, but at many the members apparently have little knowledge of safety or accident prevention, with the result that the committees devote most of their discussions to matters other than safety. Because of postwar conditions and labor unrest, management appeared to have little or no control of the mines. Despite safety organizations and safety committees, the cooperation, voluntary spirit, and personal enthusiasm necessary for the safe operation of mines are lacking.

The methods used to improve safety and the attempts to make the workers safety-conscious differed greatly at the various mines. Prizes were offered at several mines for safety posters or drawings, which were displayed. One company used small picture slides to show employees the hazardous and the safe way of working. At some mines, general safety meetings were held for all employees; at others, meetings were held for classes of selected employees before they went on shift. One company utilizes a rather large illustrated booklet, which shows how accidents are caused and gives instructions on the proper method of working. A large mine in Hokkaido had the five principal rules of safety posted at the entrance to the manway. Several companies had printed safety rules for the conduct of employees. These are but a few of the methods employed by some companies, and it shows that attempts are made to create safety-consciousness in the workers even though the reduction of accident-frequency rates is not noticeable.

Safety is strongly emphasized annually throughout the coal mines of Japan during the week designated "safety week." This is observed the first week of July and is sponsored by the Coal Board and supported by the Japan Coal-Mining Association, each district mining association, and each mine. At this time repair and replacement of safety facilities, safe operations, instruction of the workers in safety, and safety meetings are stressed. Mines or individuals are commended for good safety records or outstanding safety achievements. Considerable work and effort are expended in preparing for this week, and the number of accidents has generally declined. Thus, "Safety Week" may justify the time and effort put forth, but it does not take the place of thinking and practicing safety every day.

OBSERVATIONS AT DIFFERENT COAL FIELDS

Although many hazards are common to Japanese coal mines, unusual mining conditions and geological formations create hazards that are more pronounced in some fields than in others. This is best illustrated in the Miike and Ube fields, where the mine workings extend under the sea, and in the Joban field, where the coal measures are in a hot-spring area.

Joban Coal Field

The Joban field, which is one of several on Honshu, is on the Pacific coast northeast of Tokyo, and, despite the poor quality of coal produced, it is one of the most important coal fields in Japan because of its proximity to Tokyo and large industrial areas. The rank of the coal is lignite, which has a high ash content and low calorific value. The following analyses of raw coal from two beds in one of the large mines are typical of this field:

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	Percent	
	Upper bed	Lower bed
Moisture	11.48	9.11
Ash	31.79	31.40
Volatile matter	31.63	32.38
Fixed carbon	25.10	27.11
Total	100.00	100.00
Sulfur	4.63	2.80
Heating value:		
Kilogram-calories per pound	1,964	2,023
B.t.u.'s per pound	7,794	8,028

The prepared coal has an ash content ranging from 24 percent for fine coal (3 millimeters) to 29.5 percent for lump coal. The heating value ranges from 2,223 kilogram-calories (8,820 B.t.u.) for lump coal to 2,404 kilogram-calories (9,540 B.t.u.) for fine coal. At present, the coal is used on the railroads and by the Allied Occupation Forces; however, during and before the war the coal was used chiefly as industrial fuel and in the manufacture of synthetic oil.

The geological structure of the mines visited is very complicated. There are many synclines, anticlines, and faults. Granite is immediately beneath the coal measures, and in many places intrusions of granite occur in the coal beds. Hot springs, too, are present in most of the regions where coal is mined, which causes excessively high temperatures underground and presents a constant danger of flooding the mines with hot water. Where the granite intrudes the bottom coal bed, the hazard of a sudden inrush of water is always present.

Five beds in one part of the field and six in another are known to be workable; however, only two at some mines and three at others are being worked. These beds dip from 8° to 15°.

The mines of this field have a major pumping problem. They are very wet from hot water, which seeps through the roof; this water is conducted by open ditches to gathering sumps or to main sumps, from which it is pumped to the surface by large, electrically driven pumps. In several of the mines an average of almost 50 tons of water is pumped for each ton of coal mined. One company reported that 65 to 70 percent of the electrical energy required at the mine is used for drainage purposes. The temperature of the water pumped from one mine is 93° F.; this is typical of the field. At one mine the water is pumped to a large surface pond that covers approximately 1 acre and is used for bathing purposes. During the visit to this mine in February 1948, many of the workmen and people of the town were bathing in the pond, although the temperature of the air was considerably below the temperature at which water freezes.

The working sections are exceedingly warm because of the hot water that falls from the roof, and the mine atmosphere has a high humidity, usually 90 percent or more. At the Yumoto mine, Joban Coal Mining Co., a temperature of 93° F. and a relative humidity of 100 percent were measured at the bottom of a shaft through which approximately 240,000 cubic feet of air per minute was being exhausted. Also, a temperature of 103° F. for both dry- and wet-bulb thermometers was measured at one of the working faces. The records of this company disclose that the maximum temperature at this mine for December 1947 was 47° C. (116° F.), and the mean average for the month was 104° F. The Yumoto mine is considered the hottest in the field. The others are not quite as warm and have temperatures ranging from 80° F. to 90° F. The workmen at the face wear very little clothing - a breech cloth and split-toed rubber shoes. The high underground temperature materially reduces the efficiency and productivity of the worker. Many of the workers spend less than half their time at work; the remainder is used as rest periods. It was reported to the author that after about 15 minutes of work the miners stand under a shower or a discharge of cold water piped from the surface, thus alternately working and attempting to cool off. Records were not available as to the effect of high temperatures upon the general health of workmen in these mines.

The danger of inrushes of hot water from hot springs has been mentioned and, where this hazard is present, the panel system of mining is employed and provisions are made to close off the area from the rest of the mine by heavy steel doors set in reinforced-concrete bulkheads at the entrance to each panel. At times of inrush of water, or flooding, tracks and wires are removed within a few minutes, and the doors are then closed. Pilot or test holes are drilled ahead of the face and at angles to it in areas where water is expected. Fatalities and injuries have resulted from flooding of mines; the most recent occurred in December 1947, when five persons were killed and one was injured.

Another great problem in the Joban field is the spontaneous firing of coal in place, such fires being quite common. In one section of the field, fires break out in the fractured coal at the corners of places turned off haulageways. The ventilation is generally good at these places, but the bed is fractured, and fire starts about 6 feet inside the rib. The ribs are subjected to both vertical and horizontal pressures, which cause heat, and the coal oxidizes rapidly on exposure to air. The heat is not dissipated quickly enough to prevent the coal from heating to its ignition temperature. The mine officials believe this may be the cause of spontaneous heating of the coal or that the heat may result from the drying out and "spalling off" of the coal at the face; nevertheless these are high-oxygen coals that fire easily. Sections of several mines, which were just in the development stage, have been sealed because of fires resulting from spontaneous combustion.

The roof is not bad in most mines, and falls of roof and face cause only 34 percent of fatalities in the mines visited. This is a considerably lower percentage than the general average for most fields and individual mines.

Ventilation

All mines are ventilated mechanically by fans operated exhausting. The volume of air is ample in the slopes, entries, and haulage-ways, but little air movement is apparent in face regions. A split system of ventilation is employed, which is supplemented by blower fans (called local fans) having 15- and 19-inch diameter steel tubing for conducting the ventilating current.

These fans are not very effective, and recirculation of air occurs. Although enough air enters the mines, it is not conducted to the working places efficiently, and too much dependence is placed on blower fans.

No methane was detected in one mine, which was considered nongassy, but the other mines liberated small percentages of methane. Preshift examinations are required in mines where methane is liberated and men are searched for smokers' articles before they enter the mines. According to reports of one large mining company in this field, 12 fatalities resulted from gas explosions in one mine during 1947. Rock dust was not distributed in any mine, because all working places and passageways were wet.

Face Preparation and Use of Explosives

Along the longwall faces coal is broken from the face by pneumatic picks; when picking becomes too difficult, however, small charges of explosives are used. In room-and-pillar sections explosives are used extensively, although a considerable tonnage of coal is broken with pneumatic picks. Company rules prohibit the use of explosives if methane is known to be present.

Ammonium nitrate explosives of a "permitted" type are utilized for blasting coal, and dynamite is utilized for rock work. Electric detonators or detonator and fuse are used for firing shots. Capped fuses were found stored with explosives near working places, and little attention was given to safe handling and storage of explosives underground.

Accident Statistics

The fatality and nonfatal-injury rates are exceptionally high in this field. One large company that operates several collieries having several pits produced approximately 834,000 metric tons with 10,944 employees during 1947 and had a fatality rate of 45.5 and a nonfatal-injury rate of 5,882 per million tons of coal. An average of 0.26 ton per day is produced by each employee throughout the year.

The following table gives the fatal and nonfatal-injury rates of another large operation in this field for a 5-year period:

TABLE 8. - Injury rates in Joban coal fields

Year	Tonnage	Fatalities	Injuries	Fatalities per million tons	Nonfatal injuries per million tons
1943...	390,320	7	979	17.9	2,508
1944...	476,704	14	933	29.4	1,957
1945...	307,181	13	549	42.3	1,777
1946...	264,677	11	691	41.6	2,611
1947...	282,300	16	780	56.7	2,763

The fatality rates show a marked increase from year to year and increased threefold in a 5-year period. The greatest increase occurred since the end of hostilities.

Safety Organization

The companies in this field have a director of safety and a safety organization at each mine.

The Sendai Branch of the Japan Coal Association conducts a training school for the workers of the Joban field for the purpose of training face workers in safety. The men are trained at 6-month intervals and are paid by the companies while attending. The school is financed by the Coal Association, which obtains and pays the instructors.

Hokkaido Coal Fields

The Ishikari coal field is the largest in area and the largest producing field on Hokkaido, the northernmost island of Japan. The island also has several other widely scattered coal fields, but only one (Kushiro) is of commercial importance. The Kushiro field lies along the southeast coast of the island and is close to the seaport of Kushiro. This field, which is the second largest producer on Hokkaido, was developed extensively several years before the war, and production greatly increased during the war years; however, production is small in comparison to that of the Ishikari field. The remaining fields of Hokkaido are small and contain mines having small production.

Ishikari Coal Field

The Ishikari field lies in the west-central part of Hokkaido and covers an area approximately 43 miles long and 9 to 15-1/2 miles wide. It is the second largest active field in Japan and produces about 25 percent of the coal mined in Japan. It also contains some of Japan's largest coal mines, four of which produced between 1 and 2 million metric tons each annually during the war; of these, one produced more than 2 million metric tons annually during that period.

The field has many districts in which the geological structure differs; however, in general the structures are complex. In some districts the strata have been severely disturbed and contain many synclines and anticlines, often accompanied by faulting. Both normal and overthrust faults are extensive in some districts.

Two hundred coal beds have been identified in this field; of these, 50 are considered workable, being at least 80 centimeters (31 inches) thick and of good grade. Beds 8 to 10 feet thick are worked in some mines, but generally the mined beds average 1-1/2 meters (57 inches) in thickness. When more than one bed is worked in a mine, the uppermost bed is mined first. The coal beds dip from 15° to 75°, but most of the coal is produced in the flatter, disturbed areas. In some mines, however, a considerable tonnage is produced from steeply dipping beds.

The coal of this field is of bituminous rank and has a high calorific value, which averages 3,305 kilogram-calories (13,114 B.t.u.). Some of the coal of the field makes a good-grade metallurgical coke; however, such coal is found in only two districts. This part of the Ishikari field is one of the few areas in Japan where coke can be produced, because most of the Japanese coke is made by blending coal from several sources. Before the war, coal was imported for blending with domestic coal.

At present, virtually all coal is mined by the advancing longwall system, the length of face ranging from 60 to 120 meters (197 to 394 feet), depending on the dip of the bed. In areas where the beds dip gently the faces are 120 meters long, whereas with steeply dipping beds (over 35°) the faces are only 60 meters in length. The entries or galleries are driven on the strike. With gently dipping beds, the longwall faces are driven at right angles to the entries. With steeply dipping beds, the face is driven at an angle to the entries, so that the inclination of the face is about 30° with the horizontal.

With gently dipping beds, timber cribs are built to support the roof at the longwall faces, and in most mines the cribs are recovered as the faces advance. Roof material, debris from mining, or debris from the surface is used for filling cribs. Packwalls are built in the mined-out area as a longwall face advances, and open-end packwalls are kept close to the cribs. The packwalls are made of waste material placed between the floor and the roof; they are 6 to 9 feet wide and built so that their longitudinal axes are approximately perpendicular to the longwall face. The open space between adjacent packwalls is 18 to 30 feet, which gradually fills as the roof caves. With steeply dipping beds, the workings are backfilled completely for roof support.

In the mines visited, the coal from longwall faces was hand-loaded onto chain-trough or belt conveyors and transported to mine cars in the entries. Haulage on levels is by battery or trolley locomotives or by endless ropes. Rope haulage is used on main and secondary haulage slopes.

One mine in this field employs belt haulage exclusively from face to surface. Belts range in width from 24 inches for gathering to 40 inches for the main slope belt. The main belt is installed in a rock slope on an inclination of about 12° and is 2,000 meters (6,562 feet) in length. The company officials report that nearly 26,000 meters (85,300 feet) of belting are in use in this mine.

In steeply dipping beds, the coal moves by gravity through a steel chute to pockets, from which it is loaded into cars. Pillars are left along roadways in which pockets or batteries are provided for collecting coal from the face.

Coal-cutting machines are utilized in some mines; however, only one machine, a CLE2 Sullivan longwall, was observed at the mines visited. Several other coal-cutting machines were reported in operation at this particular mine. These are of Japanese manufacture and are similar to the Sullivan CLE2. Before the war many cutting machines were in use, but owing to the lack of replacement parts only a few are used at the present time.

The coal at the face is broken with pneumatic picks or by "shooting off the solid," except in the few places where the coal is undercut by machines.

Holes for blasting the coal are drilled by electric or compressed-air drills, and "jackhammers" are utilized for drilling rock. "Permitted" explosives are employed for blasting the coal in most mines. The law requires only permitted explosives in mines classed as gassy or dusty. Shots are fired electrically with detonators that are equivalent to No. 6 in strength. Incombustible material, usually fine clay or shale in the form of balls, is utilized for stemming. Wooden tamping bars are used. The firing of shots is under the supervision of local supervisors or special shot firers known as "shooting guards."

A type of sheathed explosive, described later, was used at some of the mines visited. At others, explosives were not permitted for blasting the coal as a precaution against mine explosions. A study of the causes of gas and dust explosions for the past 10 years discloses that 40 percent were caused by explosives or occurred during blasting.

The mines are ventilated by fans installed on the surface and operating exhausting. Nearly all the larger mines visited had fans of large capacity that could have provided ample air if it had been distributed properly. Face ventilation was generally poor. The longwall system of mining, particularly in steeply dipping beds, makes it difficult to provide ample face ventilation. Local or blower fans are used extensively to ventilate faces and dead-end roadways, which are driven in advance of longwall faces. In many instances the fans recirculate the air.

Methane is liberated in most mines in the Ishikari field, and many are classed as gassy by the Coal Board. These mines are supposed to operate with permitted or permissible equipment and to follow regulations pertaining to gassy mines. Preshift examinations are made, and examinations for gas are required during the shift. Flame safety lamps and methane detectors manufactured in Japan are employed for the detection of gas; however, at several mines visited flame safety lamps were not permitted underground, and all examinations were made with methane detectors. Old and abandoned workings are sealed because of the danger of spontaneous fires.

The volume of air passing through the mine workings and the methane content at faces and in return airways are measured frequently and recorded.

Rock dust is utilized in most mines, and the amount applied depends on conditions in the mine. Rock dust usually is prepared from shale, which is baked and then crushed to proper fineness. Entries were fairly well rock-dusted, but rock dust was not applied in face regions of longwall workings. Rock-dust barriers are installed and are of two types: (1) trough type, erected in the center of the entries, and (2) shelf type, erected along the sides of the entries. The barriers did not contain enough rock dust, according to United States standards.

Some water is used to allay coal dust. Compressed-air-operated sprays were observed near working faces and near the top of longwall faces. Water was piped to a barrel, from which a pipe extends that has an end opening of small diameter. Compressed air forces the water through the pipe and causes it to discharge as a fine spray. Water is not used on the cutter bars of the few cutting machines that are operated. The shortage of pipe and fittings is given as the reason for the small number of sprays for wetting the coal at the working face.

Accident Statistics

The fatality and nonfatal-injury rates for the mines in Hokkaido are exceedingly high. The following table gives the number of accidents and the rate per million tons of coal mined. It should be noted that this table gives the number of accidents and not the number of injuries; undoubtedly more than one person was injured in many of the accidents.

TABLE 9. - Accidents in coal fields of Hokkaido, 1926-46

Year	Production (1,000 metric tons)	Accidents	Accidents per million metric tons
1926..........	5,903	13,939	2,361
1930..........	6,726	7,737	1,150
1935..........	8,318	5,398	649
1940..........	15,377	13,937	906
1941..........	15,746	14,167	900
1942..........	15,656	14,402	920
1943..........	15,647	15,030	961
1944..........	14,409	15,722	1,091
1945..........	6,969	12,883	1,849
1946..........	5,802	8,708	1,501

This table reveals that during most of the war years there was little change in the rate of accidents per million tons, but near the end of the war and during the postwar years the rate increased greatly.

The following table giving the cause of accidents for the years 1945 and 1946 shows the high loss of life that occurred in the mines during the last year of the war. The number of fatalities and nonfatal injuries was greatly reduced in 1946, but this does not indicate a definite trend downward, as the preliminary figures for 1947 show a marked increase over those of 1946.

TABLE 10. - Causes of accidents in Hokkaido, 1945-46

Causes	1945		1946	
	Fatalities	Nonfatalities	Fatalities	Nonfatalities
Falls of roof and coal...	280	4,128	75	2,441
Haulage..................	99	2,572	44	1,538
Electricity..............	16	553	2	277
Gas and dust explosions..	34	24	19	20
Miscellaneous underground	49	3,717	22	3,027
Total underground.....	478	10,994	162	7,303
Surface..................	36	1,644	23	1,357
Total.................	514	12,638	185	8,660
Production, tons.........	6,969,000		5,802,000	
Rate per million tons....	73.8	1,813	31.9	1,493

Table 10 indicates that falls of roof and coal are the greatest cause of both fatalities and nonfatal injuries, followed closely by haulage. During 1945 and 1946 there were no large-scale mine explosions, which in previous years caused large loss of life in Hokkaido mines. Table 11 shows the great loss of life in the Hokkaido mines from explosions during the 9 years 1938 to 1947, inclusive.

TABLE 11. - Explosions and injuries, Hokkaido mines, 1939-47

Year	Explosions		Injuries		
	Major	Total	Fatal	Nonfatal	Total
1939..............	4	8	50	62	112
1940..............	3	12	111	47	158
1941..............	3	9	239	56	295
1942..............	2	15	70	96	166
1943..............	6	16	74	98	172
1944..............	6	17	196	118	314
1945..............	3	9	34	22	56
1946..............	1	4	19	23	42
1947..............	0	5	5	12	17
Total.............	28	95	798	534	1,332

Many of the explosions did not result in loss of life, and nearly all were local in nature, so that the effects were not widespread. Two explosions occurred in the same mine a few years apart and caused 177 and 109 fatalities, respectively. A study of the causes of all explosions reveals that blasting caused approximately 40 percent, smoking 20 percent, electricity 15 percent, and the remainder were from miscellaneous causes.

The number of explosions with large loss of life in Hokkaido mines indicates that one of the foremost problems in this field is to place more emphasis on the prevention of explosions, because during this period the rate was almost one explosion for each million tons of coal mined with an average of 8 fatalities per explosion.

Tables 12 and 13 were taken from records of several large mines and are given to illustrate the great increase in accidents and loss of tonnage in the past few years.

TABLE 12. - Injury rates (fatal nonfatal), mine "A", Hokkaido, 1944-47

Year	Tonnage	Injuries	Injury rates per-	
			Million metric tons	Thousand shifts
1944......	427,000	298	698	0.36
1945......	214,000	222	1,037	.30
1946......	148,300	260	1,753	.53
1947......	204,100	437	2,141	.72

Although mine "A" is the most gassy in Japan, it has received several awards for having one of the best safety records in the Hokkaido coal fields.

TABLE 13. - Injury rates, mine "B", 1943-46

Year	Tonnage	Employees	Fatal	Nonfatal	Rate per million metric tons Fatal	Rate per million metric tons Nonfatal	Production per man per day, tons
1943..	2,165,700	10,666	56	2,307	26	1,065	0.688
1944..	2,271,700	13,193	55	2,758	24.2	1,214	.506
1945..	1,130,100	6,566	47	1,346	41.6	1,191	.337
1946..	723,550	9,733	10	1,316	13.8	1,819	.272

Mine B is typical of most mines in Japan wherein a decrease in tonnage is accompanied by an increase in injury rates and a decrease in worker productivity. In 1937 (not shown in table 13), mine "B" produced nearly 2 million tons of coal and employed approximately 5,000 workers, with a daily output per worker of 1.477 tons; however, when the number of workers increased, a decrease occurred in the daily production per worker. Since 1945, the number of surface workers has been almost the same as the number of underground workers, the over-all distribution of coal-mine employment for Japan is approximately 53 percent underground workmen and 47 percent on the surface.

Table 14 gives the number of the surface and underground workers and the daily production per employee of a large colliery in the Ishikari coal field for various months of the past few years.

TABLE 14. - Workers and production, mine "C"

Date	Number of workers Surface	Number of workers Underground	Number of workers Total	Number of diggers	Production metric tons	Production per man per day 1/
April 1945.....	2,641	4,584	7,225	2,400	117,800	.60
Dec. 1945......	2,071	2,268	4,339	498	26,500	.23
April 1946.....	2,509	3,083	5,592	836	40,050	.27
Dec. 1946......	2,819	3,685	6,504	1,672	45,000	.26
April 1947.....	3,058	3,744	6,802	1,711	46,500	.25
Dec. 1947......	3,198	4,026	7,224	1,778	62,240	.32
Jan. 1948......	3,174	4,120	7,294	1,854	57,200	.29

1/ Based on 27 working days a month.

Although table 14 covers periods during only a few years, it illustrates what is occurring in the labor situation at Japanese coal mines since the end of the war. It should be noted that although the number of workers in January 1948 was almost the same as in April 1945, production was only half as much. A major cause of this condition may be the higher proportion of surface workers to underground workers than formerly.

Safety Organizations

Each of the mines visited had some sort of safety organization, but the type was by no means uniform at the various mines. Generally, a director is in charge of the safety organization at each mine or colliery. He has direct supervision over the men in charge of safety at each mine, both surface and underground. The safety director, who usually has several assistants, is responsible for inspections and safety practices in and about the mine.

Mine-rescue stations are maintained at each mine, they are well-equipped and are under the direction of a supervisor, who maintains the equipment and keeps it in readiness for use. Each mine has a mine-rescue organization composed of several well-trained teams, or crews. One mine had 110 trained men and 30 sets of mine-rescue apparatus.

Safety posters, designed by members of the mine staff, are displayed at several mines. One mine has what they consider the five important rules of safety posted over the entrance to the man slope.

Observation of Special Interest

Specially constructed cars provided with seats and enclosed tops are used for man trips in slopes. The car attached to the hoisting rope is provided with a safety device to stop the trip if the rope fails. The device is a heavy drag that is installed under the car and can be operated in one of three ways: (1) Breaking of the rope releases a heavy weight, which actuates a "trip," permitting the drag to fall; (2) a governor on the device, which releases the drag if the speed increases beyond a fixed point; and (3) a manual control, which releases a lever controlled by the trip attendant, permitting the drag to fall.

All man-trip hoists are equipped with overspeed and overwind controls.

At one mine the return air contained methane ranging from 1.60 to 1.90 percent, and the man trip is operated in the main return slope. A unique nonexplosion-type signal is provided; this consists of a 1-inch pipe extending along the center of the slope to the surface, the outer end of which extends to a point in contact with a needle of a relay, then to an amplifier in the hoist house. Signals are given by striking the pipe, and the sound is transmitted to the hoist house. The entrance to the manway slope of the mine is provided with two revolving doors, which form an air lock. Smoking and open lights are not permitted within 350 meters (1,148 feet) of the man entrance or return airway of this mine, and signs are posted along all roads and paths leading thereto.

Many of the mines in the Hokkaido field utilize a type of sheathed explosive for use in gassy mines. The cooling agents sodium chloride and magnesium sulfate are mixed with molasses and are spread between two rolls of paper of medium thickness and approximately 6 inches wide, which is cut into sheets 11 inches long. The sheets are wrapped around explosives cartridges shortly before they are inserted in a borehold. The sheath has proved very effective, and no coal-dust or gas explosion has occurred when they were used.

Methane liberated from one mine in this field is utilized for heating. As working places are completed, they are sealed tightly; the seals are about

1 meter thick and have pipes extending through them. A series of pipe lines carry the methane from the sealed areas to an exhaust fan on the surface and thence through a scrubber. The methane content in the sealed areas ranged from 50 to 65 percent, and at present methane is being exhausted from the mine at the rate of 459 cubic feet a minute. The maximum amount of methane (1,400 cubic feet a minute) was obtained during January 1940.

The methane is piped from the scrubber to a furnace that burns shale for the preparation of rock dust; methane also is burned under a boiler that heats water for the bath house; and some is delivered to a compressor plant, where the gas is compressed and stored in cylinders for automotive use. A pipe line also extends to an experimental mine on the property, wherein tests are conducted on explosives in the presence of explosive gas.

Coal Fields of Kyushu

In December 1947, 154 mines were active on Kyushu, the southernmost of the three main Japanese Islands. These mines produced 55 percent of the coal mined in Japan. Those on Kyushu produced an average of 30 million tons annually from 1939 to 1943, inclusive, slightly more than 27 million tons in 1944, but only 12 million tons in 1945. In 1946 the tonnage was slightly greater than in 1945 and almost 16 million tons in 1947; thus, the postwar production is only 40 to 50 percent of the 1939-44 average.

According to Report No. 103, Natural Resources Section (Supreme Commander for the Allied Forces), there are nine coal fields on Kyushu, most of them in the northern and northwestern parts of the island. One field, the Nishisonogi, consists solely of mines situated on several small islands lying 5 miles off the western coast in the China Sea and 7 miles from Nagasaki. Almost all the mine workings are below the sea.

The Chikuho field, in the northern part of Kyushu, is the largest producer and the most important field in Japan.

Large sections of the mine workings in the Miike field, near the City of Omuta, along one of the inland seas in the west-central section of the island, extend beyond the shoreline and under the sea.

The Amakusa field, which contains several mines, is on a large island off the west coast of Kyushu. The coal produced is principally anthracite, of which several hundred thousand tons is produced annually.

The Hokusho, Karatsu, and Kasaya-Fukuoka fields, though not very large, are important to the economy of Japan. During the war these fields produced 1-1/2 to 3 million tons annually but since 1945 production has decreased by more than two-thirds.

The Asakura and Kokura fields are small and of little importance.

The coal beds of Kyushu range in rank from medium-grade bituminous to anthracite, and the heating value ranges from 2,722 to 3,175 kilogram-calories (10,800 to 12,600 B.t.u.).

Some of the beds in the Hokusho and Nishisonogi fields having coking qualities but are high in ash. The ash content is lowered by beneficiation; however, the coal from these beds must be blended with other coal to make metallurgical coke. Twenty-five to thirty percent of the coal mined in Kyushu is used to make coke. The coal from the Miike field also is suitable for coke and is used to a large extent in the chemical industry.

The coal deposits in all coal fields on Kyushu occur in a series of Paleogene sediments of varying thickness and overlie, nonconformably, a pretertiary-basement complex composed predominantly of metamorphic rocks and granite. The coals are tertiary, with the exception of some Cenozoic coal found in the offshort islands near Nagasaki.

Folding and faulting occur in all fields but are more extensive in the fields of the northern parts of the island. Volcanism produced andesitic and basaltic intrusions, which have disturbed the coal beds in virtually all fields and in some places have entirely destroyed the fuel value of the coal. In the Chikuho field, basaltic sills intrude into the coal beds and have coked them extensively.

The number of beds present in the different fields is not constant and depends largely on the thickness of the coal measures. The Hokusho field has the largest number (40) of known beds, of which 20 are minable. In the Chikuho field, 15 to 20 beds are exploited. The thickness of the minable beds varies in each field and even within a mine, but the average thickness ranges from 1.5 to 2 meters. The dip of the beds varies greatly within the same field and within different areas of the same field. Coal is mined from beds that dip 5° to 65°; however, most of the production is from beds that dip less than 15°.

With few exceptions, the methods of opening, developing, and mining coal on Kyushu are similar to those previously described. Before World War II, many mines on Kyushu were worked by room-and-pillar and retreating-longwall methods, but because of the demand for increased production shortly before and during the war, almost all mines changed to the advancing-longwall method of mining. Although this change increased production rapidly during the war years with a minimum of development work, it is believed to have had an adverse effect upon the injury rate and to a great extent is an important factor that has prevented the return of Japanese coal mines to normal production.

The injury rates at the coal mines on Kyushu greatly exceed those of other coal-mining sections of Japan. This statement applies generally to all the coal fields on the island; however, some mines have fairly good accident records. This will be shown later under the respective fields. Table 15 was prepared from data supplied by the Coal Board, Ministry of Commerce and Industry, for 1945 and 1947, and, for the other years, were taken from table 5, Natural Resources Section Report No. 103. The table gives the number of injuries and injury rates for all the coal fields of Kyushu.

TABLE 15. - Number of injuries and injury rates of the coal fields of Kyushu, 1942-47

Year	Production	Number of injuries		Injury rates per million metric tons	
		Fatal	Nonfatal	Fatal	Nonfatal
1942...........	30,549,000	969	61,340	31.7	2,008
1943...........	31,231,000	943	140,633	30.2	4,503
1944...........	27,392,500	1,170	73,443	42.7	2,681
1945...........	11,995,200	1,031	10,720	86.0	894
1946...........	12,260,800	583	41,968	47.5	3,423
1947 1/.........	11,863,292	406	48,333	34.2	4,074

1/ First 10 months of fiscal year, April 1947 to January 1948.

The reliability of these figures is questionable, particularly those of nonfatal injuries during 1943 and 1945. The figures include all injuries, regardless of time lost. Fifty percent of the injuries resulted in a time loss of 3 to 14 days. These statistics will not conform with those given for the total Japanese coal industry; however, table 15 gives a fair picture of the appalling loss of life and the number of injuries in the coal fields of Kyushu.

Falls of roof and coal cause the greatest number of injuries in the Chikuho field, but many fatalities result from gas or dust explosions. It is believed that conditions observed in the mines visited in the Miike and Chikuho fields are representative of mining conditions existing throughout Kyushu.

Miike Coal Field

The Miike coal field is adjacent to Ariake Bay. The Miike mine, which is the largest producing operation in Japan, is in the city of Omuta and is the only operating coal mine in this field.

The Miike mine consists of four underground units or pits - two opened by vertical shafts and two by inclined shafts or slopes. The depth of one shaft is 1,341 feet and the other is 902 feet. The lengths of the slopes are 6,890 and 3,281 feet, respectively. Coal from the slope mines is brought to the surface on belt conveyors. In the longer slope there are 12 stages of 48-inch belts having a capacity of 800 tons an hour. In the smaller slope, five stages of 36-inch belts have a capacity of 300 tons an hour.

Of the nine coal beds in this field, three are mined. The Main, also known as the 8-foot bed, ranges in thickness from 5 to 20 feet (7- to 8-foot average). Another bed, which averages more than 5 feet in thickness, is 10 feet below Main bed. The third bed, 5 feet thick, is about 270 feet above Main bed.

The dip of the coal beds varies throughout the field, but most of the workings are in the areas where the beds dip 5° to 7°. The advancing-longwall system of mining is practiced universally at present; however, before the war a modified room-and-pillar and the retreating-longwall systems were employed. These systems were abandoned, and the advancing-longwall method was adopted shortly before the war owing to the demand for increased production. Future plans call for a return to the room-and-pillar and retreating-longwall system, which will be put into effect when and if the mines return to normal production. The longwall faces average 80 meters (262 feet) in length in all the units.

Some of the mine workings of Miike mine are backfilled completely; some are partly backfilled by hand with mine refuse. Where complete backfilling is employed, the material is transported by water from the surface into the mine.

Almost all the coal is dug from the face with pneumatic or hand picks. Coal-cutting machines formerly were employed, but their use was discontinued because the coal is soft. Where blasting is required to break the coal, it is shot off the solid. Electric drills are used for drilling boreholes, except in workings that are considered gassy, and in those pneumatic drills are used.

The method of haulage varies. Electric trolley locomotives, endless ropes, and hoists transport cars to and from the bottom of the shafts and slopes. In some instances the coal is loaded directly into cars, but in most places the coal is loaded onto face conveyors, which discharge into cars.

Almost all the workings of the several component parts of Miike mine are under the sea, which makes mine drainage a major problem. One mine has the largest pump station on Kyushu. This pump station contains 12 six-stage centrifugal pumps, each driven by a 900 horsepower working against a 480-meter head (1,574 feet). These pumps have a rated capacity of 570 cubic meters, approximately 151,000 gallons of water per minute. The pumps in four units of this colliery pumped approximately 28 million gallons of water a day, and the total capacity is almost 6 million gallons an hour. Inrushes of sea water have not occurred, but the danger therefrom is becoming more acute as the mine workings are extended under the sea. It is estimated that approximately 73 percent of the electrical energy is consumed for drainage purposes.

Two units of Miike mine are worked under the Japanese regulations for gassy mines, which require that precautions be taken to prevent explosions because of the type of electrical equipment used; the remaining units are considered nongassy.

Ventilation of parts of the mine that extend under the sea presents a difficult problem. The fans operate at high ventilating pressures. The water gage of one fan was 9-1/4-inches when exhausting 440,000 cubic feet of air a minute; this fan ventilates two units and part of another. The mine air from another unit has a methane content of 0.03 percent; this unit is ventilated by its own fan, which operates against a water gage of 6.1 inches and exhausts 330,000 cubic feet of air a minute.

Recently, a large centrifugal fan about 8 meters (26 feet) in diameter and 42 inches wide, driven by a 2,200-horsepower motor, was installed to ventilate two units; the fan has a capacity of 700,000 cubic feet a minute, but it is planned to install a 3,200-horsepower motor and increase the capacity as the workings are extended.

The mine workings are warm, and the relative humidity is high. The temperature of the air at the face is variable throughout the mine, but during February 1948 it ranged from a maximum of 95° to a minimum of 72°, averaging 81° to 88°. The average relative humidity was over 90 percent.

Entries and haulageways are rock-dusted in dry areas; however, the mine workings usually are wet. Rock dust is not used in the face regions, nor was any observed in the slopes where coal was transported by belts.

The safety organization of the Miike colliery is one of the best in Japan. The colliery has a director of safety, who supervises all safety activities in and about the operation. There is a supervisor for each unit, and additional men in charge of each section. According to the company chart, 1,321 men are responsible for safety at all the units composing the Miike mine. According to American standards, only a small percentage of these employees would be classified as members of the safety organization.

Safety committees have been organized at the Miike mine. These consist of members representing management, staff, and mine workers. A central committee represents both the mine and the branch committees at each unit and investigates accidents, discusses their causes, and suggests methods of prevention.

General safety meetings are held for all employees. At these meetings, 35-mm, slides of drawings or pictures illustrating accidents from falls of roof, blasting, and haulage are shown.. Talks are given on safety and accident-prevention methods, also.

Posters illustrating actual accidents are made by staff and mine employees and displayed at places of assembly. Contests between teams of mine employees are held, and safety posters made by them are displayed in an effort to stimulate interest in safety.

Each unit of the Miike mine is equipped with underground first-aid stations, and members of trained first-aid teams are on duty on all three shifts. Mine rescue teams are organized at each unit and practice regularly. The mine is equipped with 36 self-contained mine rescue apparatuses and all necessary accessories and repair equipment.

Electric cap lamps are used exclusively in the Miike mine. Smoking is prohibited underground, and employees are searched daily before entering the mine.

Examinations are made for gas at each unit by designated employees with either flame safety lamps or Japanese-type methane detectors. In some units, examinations for gas are made (or are supposed to be made) constantly during the day shift. The safety foreman of each section examines all working places and passageways under his charge. Examiners of the Safety Department make periodic and regular examinations for gas in all the units.

Man-trips on slopes are enclosed or covered and are provided with a safety car equipped with a braking or safety drag, which automatically stops the trip if the rope breaks. Hoists for slopes and shafts are equipped with overwind and overspeed devices.

Despite having one of the better safety organizations and instituting many safety precautions, the accident rates in the Miike field are exceedingly high when judged by American standards, but are better than average for Japanese coal mines. Table 16 was compiled from information furnished by the Safety Department of Miike mine.

TABLE 16. - Injury rates, Miike mines, 1940-47

	Number of injuries					Rate per million metric tons	
Year	Fatal	Major	Minor	Total	Production	Fatal	All injuries
1940..	59	37	4,029	4,125	3,771,037	16	1,094
1941..	90	49	5,112	5,251	3,757,300	24	1,398
1942..	73	28	4,289	4,390	3,536,861	21	1,241
1943..	62	42	3,894	3,998	3,779,350	16	1,058
1944..	1/159	47	3,198	3,404	4,031,653	39	844
1945..	93	20	1,249	1,362	1,609,893	58	846
1946..	43	16	2,426	2,485	1,521,310	28	1,633
1947 2/	28	6	1,269	1,303	827,111	34	1,575

1/ Underground fire in Mikawa pit.
2/ 6 months only for 1947 fiscal year.

A study of table 16 reveals that the number of injuries and injury rates fluctuate from year to year. The injury rates for 1946 and 1947 indicate that little progress resulted from accident prevention or safety work during these years.

During the period 1940-47, falls of roof or coal caused 59.4 percent of the fatalities. Haulage was the second and accounted for 16 percent of all fatalities. Deaths by mine fires was 9.5 percent; however, this was due to the large number of lives lost in a fire in one of the units during 1944.

The total number of employees during the period 1940-47 averaged 20,000 annually; however, during 1944 approximately 24,000 workers were employed. The tons per month per worker decreased from 24.3 in 1940 to 6.4 in 1945. At present, however, the rate is gradually increasing and ranges from 8 to 9 tons.

Chikuho Coal Field

The Chikuho coal field, in the northern section of Kyushu, extends from the sea inland for a distance of 30 miles and is 7-1/2 to 18-1/2 miles in width. It is the most important coal field in Japan because of its nearness to the Japanese heavy-industry and manufacturing districts and produces more coal than any other Japanese coal field. Approximately 35 to 40 percent of all coal produced in Japan between 1935 and 1945 was mined in the Chikuho field. During the war, several collieries produced more than a million tons annually, but since 1945 these collieries are producing only 40 to 50 percent of the former tonnage.

Four groups of coal-bearing formations exist in this field; some occur throughout the field. The beds in some of the formations are present and workable only in parts of the field. The field is much faulted, and the lower formations in the southern end of the field have been intruded by plugs, dikes, and sills, which have coked the coal and destroyed its value as a fuel.

The coal of the field is noncoking-bituminous with an average heating value of 11,000 B.t.u. for fine sizes and several hundred B.t.u.'s lower for lump. Run-of-mine coal requires cleaning, and all mines have large surface cleaning plants, and the cleaned coal from some beds has a heating value of 13,000 B.t.u.

The dip of the coal beds is not uniform throughout the field, but most of the mine workings are in areas where the beds dip 15° to 20°.

Mining practices and methods of development are somewhat uniform throughout Japanese coal mines, and the mines in the Chikuho field follow the general Japanese practice. The mines are opened by slopes and vertical shafts, the former predominating. The slopes are driven to the dip either in coal or in rock under the coal. Entries 60 to 100 meters apart are driven singly on the strike from the slopes, and longwall faces are driven between the entries. Slopes and tunnels are driven from entries to intersect other coal beds when several coal beds are worked from the same opening. In one mine visited, "rock chutes" dipping 50° are driven off the entry to intersect two overlying coal beds; these are utilized as loading chutes or pockets. At points of intersection of rock chutes and beds, entries or counters are driven on the strike of the coal, from which longwall faces are developed. Coal mined at the longwall faces is hand-loaded onto conveyors, which transport it to "mother" conveyors in the entries. Mother conveyors discharge the coal into a chute, from which it passes into cars.

The advancing longwall method of mining is followed in virtually all mines. The length of face depends on local mining conditions; however, the average length ranges from 60 to 80 meters (196 to 262 feet). Some of the more progressive mines are planning to change to a more mechanized method of mining; however, these plans await the development of new workings and more adequate ventilation.

Backfill is used to some extent in all mines, but at most only part of the open areas are backfilled. Material for backfilling is mine waste including roof rock, which is hand-packed into pack walls 3 meters thick and 6 meters apart. Several mines are backfilled by hydraulic methods, and the material is transported from the surface through pipes. Bamboo lattice work is used for holding the backfill and for draining off the water.

Coal-cutting machines are not used extensively. Almost all the coal beds in the Chikuho field contain silicified wood, which is found in the lower part of the bed and makes cutting of the coal difficult; nevertheless, the coal is cut with machines in a few mines.

Coal is generally broken from the face with pneumatic picks. Where it is necessary to blast the coal, it is shot off the solid by shot firers.

Holes are drilled with pneumatic drills, but electric drills are used in some mines where gas is not present. Permissible explosives are generally used for blasting. Holes are stemmed with noncombustible material.

Electric cap lamps are worn by all underground employees. In the mines visited, smoking was not permitted underground, and workers are searched before they enter the mines. At some mines, workers are searched for explosives when they come off shift.

Methane is found in nearly all mines in the Chikuho field, and, in order to prevent explosions, all the mines visited were observed to be working under the 1940 regulations for gassy mines. These regulations require that (1) permitted equipment and permitted explosives be used, (2) mines be inspected before the shifts enter, and (3) examinations for gas be made during the working shift. This field experienced some disastrous explosions in the past, the worst occurring in 1914, when 667 lives were lost.

Main entries and inside slopes are rock-dusted, but little if any rock dust is used at the working faces or in the old workings back of the faces. Considerable rock dust is applied for each ton of coal produced, but when the extent of the workings and the production of each pit are considered, the quantity used is far from adequate. The mines in this field use limestone dust for rock dusting and have difficulty in obtaining enough to do an efficient job. Sprays are used to a limited extent at some mines to allay dust along slopes, but none was observed in use at the working faces. The lack of enough sprays to wet the coal is attributed to the shortage of pipe and fittings.

Large volumes of ground water are not encountered in most of the mines in this field except in the mines that are near the sea in the northern end of the field. Thus, mine drainage becomes a greater problem as the mine workings approach the sea.

Ventilation is induced by centrifugal fans that operate exhausting. Main slopes and main development entries are driven parallel. In the large collieries, or mines, each usually is ventilated separately; however, if several mines are close together, they may be ventilated by two or more fans. Difficulty is encountered in ventilating longwall faces or mines where contiguous beds are worked. Blower fans and sheet-iron tubing 22 to 24 inches in diameter are used to supplement ventilation provided by the main fans.

Haulage is by endless rope, tail rope, or engine plane systems. Loaded cars are pushed by hand to main gathering points from whence they are transported by rope haulage. At longwall faces, coal is ordinarily hand-loaded into conveyors, which discharge into cars.

Spontaneous combustion in old workings is a major problem at some of the other mines in this field; the hazard is reduced by sealing abandoned workings. In one mine, old workings are back-filled hydraulically.

Each of the mines visited had some type of safety organization; some were more elaborate than others. A supervisor or safety is in charge of safety activities at each colliery. He is assisted by subordinate supervisors.

Safety committees composed of laborers, staff (supervisors, subprofessional and professional workers), and management officials were organized recently at each mine, but their value is unknown at present. Some companies are attempting to create interest in safety by training (lectures and conferences) the underground laborers before they enter the mines. Many companies have their own safety rules for the guidance of employees.

All mines visited had well-rganized mine-rescue teams and well-equipped mine-rescue stations. The men are trained and in readiness to assist at disasters, but the ordinary mine laborer has no knowledge of first aid as practiced in the United States.

Vertical-shaft and slope hoists were equipped with both overwind and overspeed devices at mines where man-trips are operated. Cages in shafts are not equipped with safety dogs or safety catches, because most of the Japanese engineers do not believe they are effective. Man-trip cars on slopes are provided with seats, and the top and sides are covered with heavy sheet iron. Each man-trip is equipped with a safety car; this car is attached to the hoisting rope and has a safety device for stopping the car if the hoisting rope should fail. The device is a drag placed under the safety car, and it works automatically when tension in the hoisting rope is released. The safety device is connected to a governor and is activated when definite speeds are exceeded; or it can be activated manually. Man-trips are under the control of two rope riders - one at each end of the trip - either of whom can signal the hoistman from the trip while it is in motion.

Accident Rates and Statistics

The Chikuho field has high fatality and nonfatal-injury rates, which have shown a marked increase since the end of hostilities in August 1945.

Statistics and other data were collected at each mine visited, and tables 17 to 22, inclusive, were compiled from the study of these data. Many of the data cover only a few months, so that it is difficult to arrive at definite conclusions as to the actual trend of injury rates in the past few years. The tables show the number of injuries, injury rates, and number of workers. Because of the incompleteness of these data, only a vague idea may be obtained of the safety and efficiency of the workers in these mines.

Mine A

This is one of the largest in the Chikuho field, producing more than a million tons annually from 1938 to 1943, except during 1942. At present, the annual production is approximately 600,000 tons. The mine consists of four units (called pits). Production is obtained from five beds.

Table 17 show the number of workers on the payroll at the end of February 1948.

TABLE 17. - Number of workers, mine "A"

Hewer	Rock men	Timber men	Total direct workers	Indirect underground workers	Total underground	Men	Women	Total	Total Underground and Surface
2,074	1,661	815	4,550	1,313	5,863	2,512	1,163	3,675	9,538

This table gives a typical distribution of mine workers. The hewer (miner or actual coal producer) constitues approximately 21 percent of all workers and 35 percent of the underground workers. It should be noted that 62 percent of the total number of employees work underground; this is a high percentage for Japanese mines, as the average for all Japanese mines is approximately 53 percent.

During the month covered by table 17, 54,000 tons of coal was produced, an average of 5.69 tons per month for each employee or 9.2 tons for each underground worker.

The number of injuries through which 3 or more days were lost from work and the injury rates for the calendar year 1947 are shown in table 18.

TABLE 18. - Number of injuries during 1947, mine "A"

Number of injuries			Production,	Rate per million metric tons		
Fatalities	Nonfatalities	Total	metric tons	Man-days	Fatalities	Injuries
25	2,206	2,231	568,796	2,804,700	44.0	3,878

The number of injuries per month during 1947 ranged from 2,280 to 5,324 per million metric tons of coal mined. Analysis of the causes of injuries revealed that falls of roof or coal caused 40 percent of all injuries. Cars and other haulage equipment caused 14 percent of the injuries. The percentages from these causes appear low and are well below the average. A study of the type of workers injured shows that hewers (miners) received 46 percent of the injuries and rockmen 28 percent; consequently, workers at the face sustain three-quarters of the injuries.

Mine B

Mine B was opened 50 years ago and at present consists of two units, each of which has several openings. Eight coal beds dipping 15° to 20° are being mined. Prior to 1945, the annual production was between 800,000 and a million tons. Production has decreased from 353,000 in 1945 to 183,900 tons a year.

The mine employs 7,268 workers, of whom 2,864 were on the surface and 4,404 were underground; of the latter, 742 are hewers (miners). According to these figures, the hewers comprise only 10 percent of the total working force, or 16 percent of all underground workers. In addition to the above-mentioned workers, 502 members of the staff, 281 technicians, 182 business or office employees, and 39 doctors are employed. The doctors are members of the staff of the large company hospital, where research and experiments on industrial health and welfare are conducted.

The tonnage produced per man-day is very low, although the output per hewer (miner) is high for Japanese mines. The following tabulation gives the output per man-day from November 1947 to February 1948.

TABLE 19. - Metric tons produced per man-day, mine "B"

Month	Hewer (miner)	All employees
November 1947	2.49	0.188
December 1947	2.58	0.211
January 1948	2.76	0.217
February 1948	2.90	0.217

Table 20 gives the number of injuries and the injury rates for the years 1937-47.

TABLE 20. - Number of injuries and injury rates, 1937-47

Year	No. of injuries		Production, metric tons	Number of Man-days[1]	Rate per million, metric tons	
	Fatalities	All injuries			Fatalities	All injuries
1937...	4	389	813,536	1,022,890	4.9	478
1938...	5	522	902,171	1,120,319	5.5	579
1939...	22	583	966,621	1,255,574	22.8	603
1940...	8	793	1,016,177	1,550,401	7.9	780
1941...	12	562	943,841	1,409,730	12.7	595
1942...	13	672	961,836	1,496,481	13.5	699
1943...	19	834	1,034,300	1,755,464	18.4	806
1944...	44	1,135	858,700	1,936,763	51.2	1,322
1945...	14	575	353,000	1,347,464	39.7	1,629
1946...	17	916	295,450	1,625,077	57.5	3,100
1947[2].	4	465	183,900	1,081,434	21.8	2,529

[1] The number of man-hours per man-day is unknown.

[2] First half.

Before 1945, the injury rates at mine "B" were better than average; but since 1945 the injury rates have increased greatly. A study of the production and man-day figures indicates that the production per man-day has decreased in the past few years. Production has decreased nearly one-third, whereas man-days have remained approximately the same and the number of injuries has increased.

The total-injury rates per million tons for the period 1939-41 (before the war) was 660, whereas for 1945-47 it was 2,310 - a marked increase. Moreover, the injury rate per 1,000 man-days showed little change - 0.453 for the 1939-41 period and 0.473 for the 1945-47 period.

Mine C

Coal was produced from four units in mine "C" and was mined from four beds, which dip from 15° to 20°. All mine workings are gassy, and considerable water is encountered in mining.

Table 21 shows a marked decrease in production per man-month from 1937 to 1947.

TABLE 21. - Production and employees, mine "C", 1937-47

Year	Production, metric tons	Average number of employees			Production per worker per month, metric tons
		Underground	Surface	Total	
1937....	677,342	1,946	724	2,670	21.1
1938....	699,448	2,226	765	2,991	19.5
1942....	606,340	2,566	1,080	3,646	13.9
1943....	606,500	2,811	1,304	4,115	12.3
1944....	492,800	2,619	1,666	4,285	9.6
1945....	245,600	1,874	1,531	3,405	6.0
1946....	178,400	1,978	1,414	3,392	4.4
1947[1/]..	96,100	2,210	1,436	3,646	4.4

[1/] First half.

Data on injuries for years before 1946 were not available. Table 22 gives the number of injuries and the injury rates since 1946. It should be noted that the mining company has three injury classifications - serious, light, and slight; however, all are lost-time injuries.

The injury rates for mine C greatly exceed the average of other mines visited in Chikuho field.

TABLE 22. - Number of injuries and injury rates, mine "C"

Year	Production, metric tons	Man-days	Number of injuries					Injury rates	
			Fatal	Serious	Light	Slight	Total	Per 1,000 man-days	Per million metric tons
1946...........	178,400	627,145	5	102	678	60	845	1.35	4,737
1947[1/]..........	96,100	353,643	2	47	614	21	684	1.93	7,118
Oct. 1947......	18,700	62,500	1	2	122	0	125	2.00	6,684
Nov. 1947......	19,200	62,831	0	4	116	7	127	2.02	6,615
Dec. 1947......	21,550	65,728	0	5	90	24	119	1.81	5,522
Jan. 1948......	21,600	62,541	0	3	112	20	135	2.16	6,250
Feb. 1948......	20,450	57,682	0	3	117	28	148	2.57	7,237

[1/] First half.

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